

BREEDING PLACES OF ANOPHELINE MOSQUITOS IN AND AROUND FREETOWN, SIERRA LEONE

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(Received for publication 6 November, 1925)

PLATE V AND MAP

The survey, details of which are given in the present paper, was undertaken during the period 26 May to 9 September, 1925, that is, at the commencement and during part of the rainy season.

We are indebted to H. O'Hara May, Esq., M.D., Deputy Director of Sanitary Services, and to the officials of the Sanitary Department, for much valuable assistance which they rendered throughout the period of the investigation.

At various times during the last twenty-five years, investigations have been made by different observers as to the prevalence and distribution of mosquitos in Freetown. During this period there have been great and progressive reductions in the number of mosquitos in general. The findings of Ross, Annett and Austen (1900), and Stephens and Christophers (1900), who examined the town and its environs for mosquitos, prove that the anophelines were present twenty-five years ago, in numbers vastly greater than could be found by any subsequent observers. It has, in fact, frequently been recorded by the latter that in Freetown itself, at any rate, mosquitos are by no means plentiful and rarely obtrude themselves in such numbers as to constitute a cause of physical discomfort. Thus Bacot (1915) writes of the apparent absence and actual rarity of mosquitos in Freetown. Blacklock (1921), who made a survey of anopheline breeding places in the town at the end of the dry season, found

anophelines practically entirely confined to their dry season residual breeding places, which were the pools in the courses of the streams which traverse the town and chiefly at the points above and below the area occupied by streets.

The present detailed survey has included not only the town portion but also, in some cases, the hilly portions of these streams far beyond the town boundaries. A number of species of *Anopheles* have been found, which have either not previously been recorded from the neighbourhood of Freetown or have been known only from a few specimens.

A plan of Freetown, issued by the Public Works Department, Sierra Leone, 1911, is reproduced in part, reduced to about two-fifths and slightly altered, at the end of this report.

The following species were found :—*

1. *Anopheles costalis* Theo.†
2. *A. funestus* Giles.
3. *A. rhodesiensis* Theo.
4. *A. smithii* Theo.
5. *A. marshalli* var. *freetownensis* Evans.
6. *A. squamosus* Theo.
7. *A. theileri* Edw.
8. *A. domicolus* Edw.

THE DISTRIBUTION AND BREEDING PLACES OF THE SPECIES OF ANOPHELES FOUND

A. costalis Theo.

At the beginning of the investigation this species was found breeding in the stream which opens at Magazine Wharf (see Map), in Nicol's Brook, in Sander's Brook and in the Alligator River. The breeding places were not evenly distributed along the courses of these streams; in the first two the most prolific breeding places were in the portions of the stream below the town, extending from the streets to the sea. Through the town there were often long stretches which proved entirely free from larvae, but they were found again in numbers at the outskirts of the town.

* All these species were determined from adults bred from the larvae or pupae.

† Christophers (1924) has shewn that the correct name for this species is *Anopheles gambiae* Giles.

There are several points of interest which may be referred to in detail. For example, the stream which opens at Magazine Wharf is, until just before its entrance to the sea, contained in a laterite drain, and here its flow is fairly rapid ; there is little or no vegetation and the water is used for washing clothes at various points. Throughout this portion no larvae of *Anopheles* were present. After it passes the railway, however, the stream bed widens out into a natural bed of a rocky and steep nature ; the pools found here contained abundant larvae, even to within a few yards of the salt water. Again, in Sander's Brook a notable feature was the regular occurrence of the breeding places at those points at which a lateral drain from the streets joined the main stream. In a stretch of stream running through the town are nine such junction drains ; at six of these, larvae were found in the semi-stagnant weedy area which existed near the junction ; they were not found in large numbers in the stream itself at these points. Certain negative findings are worth recording, e.g., no larvae of this species were found in Granville Brook, skirting the east of the town or, during July and August, in the top of Sander's Brook, above Mendi Street, where the water course has been trained so that the stream flows between loose banks of laterite stones. In September, however, larvae were taken at the latter place in the area of overflow caused by the heavy rains. Isolated breeding sites were found away from the streams in the areas adjacent to them, usually in small seepage waters or in laterite drains, especially on the east side near the outskirts of the town.

In addition to breeding places in these natural and semi-natural waters, there were breeding places of this species in such sites as the following :—

1. Pools in laterite street drains.
2. A concrete washing tank (Pl. V, fig. 4).
3. Canoes lying on the beach at various points.
4. Shallow pits dug in laterite and containing clean water or, as in one case, foul water with an accumulation of decomposing vegetable refuse.

Outside the town, towards the hills behind it, this species was only rarely found in tracing the streams to their source in the hills. The upper part of Nicol's Brook outside the town is rocky, steep

and well shaded by trees ; here *A. costalis* was replaced by *A. smithii*. It was remarkable to observe the suddenness with which the latter replaced the former species just beyond the town.

Three collections of larvae taken from water lying in exposed, flat stones, in compounds at Hill Station, were sent to us by the Sanitary Department. None of these were larvae of *A. costalis*.

In general, it may be said that in Freetown *A. costalis* breeds most freely in pools at the edges of slowly running portions of the streams ; these pools may or may not be isolated from the current. It is often difficult to say whether a pool is actually separated from the current, but it is frequently possible by stirring up the mud or sand to observe that there is a current of water circulating through pools that are apparently isolated from the stream. While vegetation is usually present in sites containing large numbers of larvae, numerous larvae have been found in water apparently free from vegetation. *The breeding places, almost invariably, are so situated as to receive a considerable amount of sunlight.* The bottom of the pool as well as the sides may be mud, rock, sand or gravel. The character of the water varied from perfectly clear to discoloured and, in one case, foul with rotting vegetation.

If the discovery of large numbers of eggs indicates a preferential breeding place, the following observation from Nicol's Brook may be of interest. Three pools of similar character yielded hundreds of eggs ; they were small, shallow pools each containing about a gallon of water, situated beside rocks in the bed of the stream. In each case the bottom was gravelly, no vegetation was growing actually in the water but low herbaceous plants overhung it on one side ; no shade was present except the small amount afforded by this vegetation and the adjacent rocks.

We did not find this species breeding in small artificial containers such as tins, bottles, native pots, nor in rot-holes in trees, nor in the water contained in the axils of such plants as *Dracaena* (the 'cocked-hat tree').

From the earliest periods of investigation of the anophelines in Freetown it has been evident that *A. costalis* has been the prevailing species breeding in the town. This was the experience of Ross, Annett and Austen (1900), Daniels (1901), Logan Taylor

(1902), and also in more recent times that of Bacot (1915) and Blacklock (1921); the last-named wrote 'This (*A. costalis*) appears at the present time to be by far the commonest Anopheline breeding at the end of the dry season in Freetown.' Comparing our findings of to-day (see Map) with those of the earliest observers we may note that while it is clear that there has been an enormous reduction of adults and breeding places since their time, it is equally clear that the numerical predominance of this species still remains. In Freetown, itself, therefore, this important carrier of malaria is the Anopheline, above all others, which has to be reckoned with. It will remain a standing menace certainly until such time as the streams through the town are treated in a radical manner.

Anopheles funestus Giles.

This species was only once found by us in the town itself; we obtained it, however, in two localities adjacent to the town. The breeding site in the town was in Elliott Street in the western area; four fully-grown larvae being found in water in a small, unshaded pit in laterite into which dead sticks had been thrown; numerous larvae of *A. costalis* were taken at this spot at the same time and on other occasions. Outside the town one site was in a garden at the point where the road to Kissy crosses Granville Brook; the larvae were found in a shallow stream of water rapidly trickling among syenite rocks, on dead leaves, with a small amount of vegetation and exposed to the morning sun. The other site was on the portion of Alligator River just above the town (Pl. V, fig. 3); they were found in small numbers over a stretch of a hundred yards of river well above the highest breeding place of *A. costalis* found by us on this stream, and separated from it by a stretch of water in which no larvae were found. The larvae at this place were found among weeds growing at the margin of fairly rapidly running water; the weeds were growing in water that was more than a foot deep in most places; there was a little tree shade and the sides and bottom of the stream were of soft mud.

It will be observed that these three breeding places were widely different in character.

Ross, Annett and Austen (1900) found *A. funestus* restricted entirely to the eastern part of the town: 'We never found a larva

or an adult of this species west of Government House Individuals were caught in a house in the town where some cases of fever had occurred at Leicester, a village high among the hills, and at some other points. The larvae were common in pools in the eastern quarters, at Kissy and other spots.' Daniels, quoted by Ross (1901), noted that *A. funestus* was found near but not in Freetown. Bacot (1915) records *A. funestus* only from outside Freetown at the following places :—Hill Station, Kissy Flats, and the area between Kissy Road and Fourah Bay. Blacklock (1921) also failed to find *A. funestus* in Freetown.

Concerning the breeding places of this species, Logan Taylor (1902) says that it seems to prefer gently running water to breed in, the larvae being found where the currents are sluggish, and especially amongst grass and weeds at the edge. Two of the sites discovered by us agree in most respects with this writer's observations with regard to the character of the breeding places of this species. It would seem that this species has almost disappeared from even the limited area of distribution in the town referred to by Ross, Annett and Austen. To-day, with one exception, it has not proved possible to find breeding places of this species without going outside the inhabited areas of the town. This apparent modification of the distribution may be compared with what may prove to be a similar modification in the distribution of *A. rhodesiensis* which, formerly not recorded from the town itself, has been found by us in scanty numbers in several widely separated spots.

Meantime, it may be said of *A. funestus* that, however important it may prove to be as a carrier of malaria outside the town, it is quite unimportant in Freetown itself when compared with *A. costalis*.

A. rhodesiensis Theo.

This species was found to occur sparsely over a wide area including a large portion of the town and the surrounding country ; fourteen breeding sites were discovered but the number of larvae found at each site was small. The largest number found was fifteen at one spot (Record No. 205), which was on the outskirts of the town near the Public Works Department. The species was also found on the eastern side of the town as far as Kissy and on the south-western as far as Hill Station, where the larvae were found by

officials of the Sanitary Department, in the water lying in hollows in large flat stones. Although the spot map shows this species to have a wide distribution it must be emphasized that it is extremely rare when compared with *A. costalis*. Its breeding sites and the associated species indicate its adaptability; in the five places in which it was encountered within the town boundary it was always associated with *A. costalis*; in two sites outside the town, in Nicol's Brook, with *A. smithii*, in another in the upper part of Granville Brook, with *A. funestus*, and in still another, at Kissy Flats, with *A. costalis* and *A. squamosus*. Considering the difference in the character of the breeding sites of these associated species, it is obvious that *A. rhodesiensis*, which for some reason is not a numerous species here, is one which is capable of adapting itself to a great variety of breeding places. It was found, for example, beside a stream almost at sea level (Pl. V, fig. 1); at an altitude of 800 feet; in streams; in road-side ditches; in rock-pools; and, finally, in a concrete washing tank (Pl. V, fig. 4). It is not possible to explain at present why this species has not previously been recorded from Freetown, although it has been recorded by Evans (1924) from close to it at the Cape Lighthouse Peninsula, and it is known from other parts of Sierra Leone. It may be that owing to its sparseness it has been overlooked in previous surveys, or that it has a definite and short breeding season; again it may be that it usually fails to develop under laboratory conditions, or finally, that it may be a recent addition to the Anopheline fauna of Freetown. We are not in a position to decide which of these alternative explanations is the correct one. It is not even possible to say whether *A. rhodesiensis* is an efficient carrier of malaria here and at present it would be a matter of some difficulty to obtain sufficient adults for the performance of transmission experiments.

A. smithii Theo.

This species was only found outside the town in the upper, hilly portion of Nicol's Brook and the Congo River. Thus it is limited to those parts of these streams which are steep, rocky and shaded by overhanging trees.

A detailed survey of this species was made in the first of the two rivers referred to.

Starting from the point just at the boundary of the town where *A. costalis* ceased to be present, *A. smithii* was suddenly found in large numbers. The amount of overlapping of the breeding places of these two species on this stream was limited to the occurrence of isolated specimens of each species in the area of distribution of the other. The stream was traced up Mount Aureole to its sources on Kortright, at a level of over 1,000 feet. The larvae of *A. smithii* were found in large numbers in pools in the rocky bed of the stream. They were mainly concentrated in two areas of the stream, one near the lower limit of their distribution, above the town boundary, and one near the upper limit not far from the source of the stream. In the intervening length of stream they were found in small numbers only.

The general characters of the breeding places of *A. smithii* are as follows. The breeding places (see Pl. V, fig. 2) are on a rocky bottom which is covered as a rule with dead leaves, often with little or no living vegetation; the water in the pools, though apparently still, was usually found to be in direct communication with the current of the stream. A considerable amount of shade was usually present, but the larvae might be exposed to the sun for certain hours daily. Larvae were, however, also found in the margins of still pools where there was abundant vegetation at the edge of the water. In one case larvae were not seen until a tangled mat of roots and creepers, which lay on the rocky bottom of the pool at the side, was lifted up, when numerous larvae were discovered. On two occasions several larvae were found in small pools sunk in the banks of the stream, the water in them almost hidden from view by a tangle of sticks and creepers.

The extreme localisation of this species, which has not hitherto been recorded elsewhere than at Mount Aureole, is of interest. The only records of it so far as we are aware are those of Theobald, who described the species from several female specimens captured on Mount Aureole by Major Smith, R.A.M.C., and, later, referred a female specimen captured by Captain Grattan, R.A.M.C., at Aureole, to this species. Captain Grattan took male specimens of this species and Theobald made them the type species of the genus *Feltinella*, calling them (*A.*) *Feltinella pallidopalpi*; Christophers (1924), in his catalogue of the Anophelines, makes *A. pallidopalpi* a

synonym of *A. smithii*. From the result of breeding out more than a hundred adult specimens from larvae we are able to confirm this synonymy.

It was found that this species continued breeding throughout the wet season, wherever suitable pools occurred in hilly portions of the streams. Searches made at intervals during the period of investigation continued to yield larvae of all stages and also pupae until the investigation ceased on September 9.

A. marshalli var. *freetownensis* Evans.

The larvae of this species were found on eight occasions in rock-pools in certain streams outside the town, but were never found in the town itself. Three records were from Nicol's Brook, at and above Aureole Bridge, three from streams near Kissy Bridge, one from a stream flowing to Granville Brook at Cline Town, and one from a tributary of the Congo River at Hill Station. The character of the breeding places may be gathered from the fact that in four cases they were associated with the larvae of *A. smithii*, in one with those of *A. costalis*, and in another with those of *A. funestus*. When found alone the larvae were in streams where a certain amount of shade was present. The larvae were found from just above sea-level to 800 feet above sea-level.

A. squamosus Theo.

Larvae of this species were found in one locality only, namely in Kissy Flats, where they were associated with those of *A. costalis*. The site was a shallow unshaded pool in the course of a ditch in laterite, with slowly running water and some vegetation.

A. theileri Edw.

Only four records of this species were obtained. Larvae were found once in association with *A. rhodesiensis* and *A. marshalli* var. *freetownensis*, once with larvae of *A. rhodesiensis*, and on two occasions they were not associated with any other species. Three of the records were, however, from places situated far apart; one being situated well outside the eastern, the others outside the south-western boundary of the town.

A. domicolus Edw.

A single specimen reared from a pupa taken in a road-side ditch at Regent, above Freetown, was referred provisionally to this species.

During the course of this investigation material was examined from various natural, small collections of water, contained in tree holes, axils of leaves, and bamboo, pineapple and banana stems. Numerous samples from such sites were examined and in spite of the fact that larvae of some species of mosquito were present in 179 cases, it was remarkable that in no case were the larvae of Anophelines found in such sites. Owing to the closure of wells in Freetown the findings of Allan (1913), who discovered *A. costalis* in twenty-eight of 418 wells, cannot, fortunately, be repeated.

SUMMARY OF CHIEF POINTS BROUGHT OUT BY THE SURVEY

Eight species of Anopheles were found either in or near Freetown.

A. costalis is still by far the most numerous species in the town itself.

The chief breeding places of *A. costalis* are in and near the courses of the four streams which flow through the town.

During the heavy rains, shallow laterite drains in streets that have no slope are also important sources of larvae. Larvae of this species were always found in situations exposed to a considerable amount of sunlight ; they were usually in entirely unshaded places.

A. funestus is found rarely in water courses on the eastern and southern sides of the town ; it was taken once in the town itself, this being the first record of its presence within the town boundary since 1901.

A. rhodesiensis was found to be widely distributed in Freetown and the surrounding hills. It was the species found in situations exposed to the sun at Hill Station.

A. smithii. Larvae of this species were very numerous in the pools in the wooded upper part of Nicol's Brook, especially from the middle of May till the end of July. In the height of the rains larvae could only exist in the pools or eddies of the stream sheltered from the force of the current. They were also taken in the Congo River

system just below Hill Station. Considerable tree-shade was usually, but not invariably, present at the breeding places.

A. marshalli var. *freetownensis* occurred outside the western, southern and eastern boundaries of Freetown, but not in the town itself. The larvae were almost always found in streams and usually in shaded situations. They were often associated with those of other species.

Other species found were *A. squamosus*, larvae of which were taken in ditches at Kissy, *A. theileri*, larvae of which we found in streams at Hill Station and to the east and south-west of the town, and *A. domicolus* Edw., taken in a ditch at Regent, behind Freetown.

KEY TO THE FOURTH STAGE LARVAE OF ANOPHELINES OCCURRING IN SIERRA LEONE.

1. Antenna with branched hair on shaft..... *mauritanus**
- Antenna without branched hair on shaft.....2
2. Dorsal plates relatively very large (fig. 4, A)..... *funestus*
- Dorsal plates relatively small and inconspicuous
(fig. 4, B and D).....3
3. Outer clypeal hairs (fig. 1, A) plumose..... *squamosus*
- Outer clypeal hairs simple or slightly branched
(fig. 1, B, C).....4
4. Outer clypeal hair more than three-fourths the
length of the inner (fig. 1, C)..... *smithii*
- Outer clypeal hairs not more than three-fifths the
length of the inner.....5
5. Thorax without palmate hairs†..... *costalis*
- Thorax with palmate hairs.....6
6. Leaflets of palmate hairs on third to seventh
abdominal segments without filament (fig. 2, B)...*theileri*
- Leaflets of palmate hairs on third to seventh segments
with filament (fig. 2, A, C-G).....7
7. Palmate hairs on fifth abdominal segment very large,
c. 0.2 mm. in diameter (fig. 2, C), sub-median
thoracic hairs with bases enlarged and fused
(fig. 6, D)..... *marshalli* var. *freetownensis*
- Palmate hairs on fifth abdominal segment smaller,
c. 0.15 mm. in diameter (fig. 2, A), sub-median
thoracic hairs with bases well separated (fig. 6, B)... *rhodesiensis*

* The larva of *A. obscurus*, Grünb. probably possesses this character.

† Palmate hairs are here understood to be structures having a short stout base from which arise distally a number of leaflets mostly sub-equal in length.

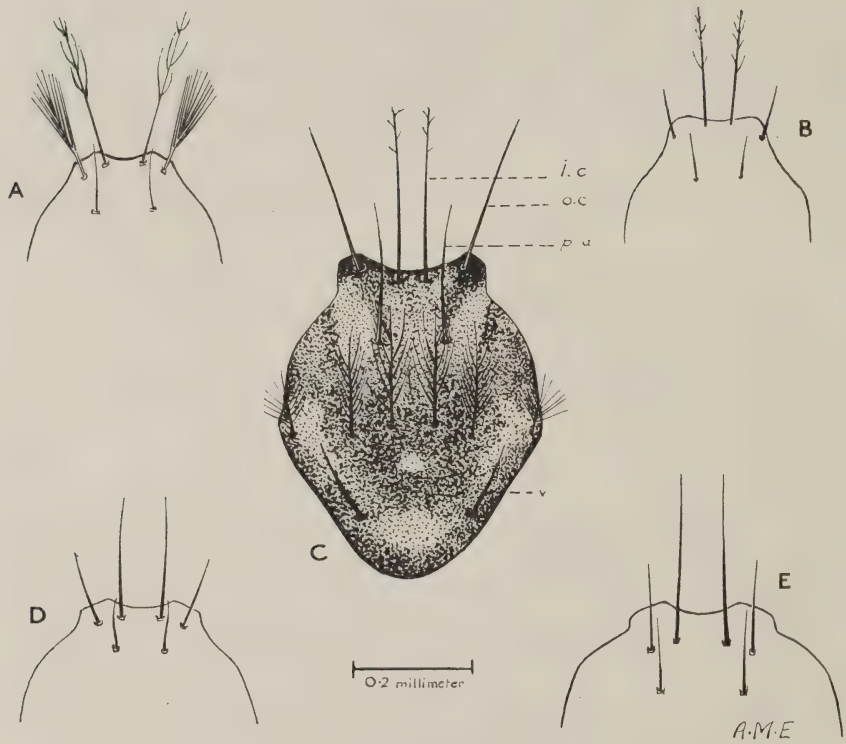


FIG. 1. Clypeal and post-antennal hairs of A.—*A. squamosus*; B.—*A. costalis*; D.—*A. rhodesiensis*; E.—*A. marshalli* var. *freetownensis*; C.—clypeus and vertex of *A. smithii*; i.c.—inner clypeal hair; o.c.—outer clypeal; p.a.—pre-antennal; v.—vertical.

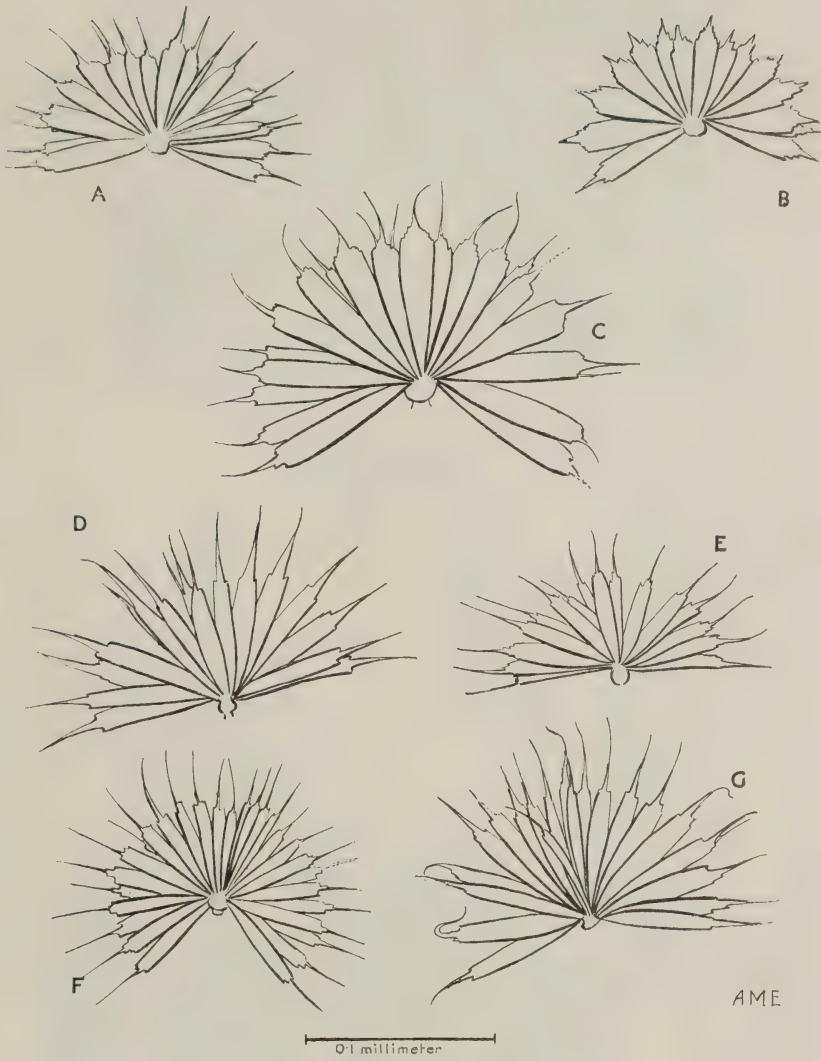


FIG. 2. Palmate hairs of fifth abdominal segment. A.—*A. rhodesiensis*; B.—*A. ibcileri*; C.—*A. marsballi* var. *freetoconensis*; D.—*A. squamosus*; E.—*A. costalis*; F.—*A. funestus*; G.—*A. smitbii*.

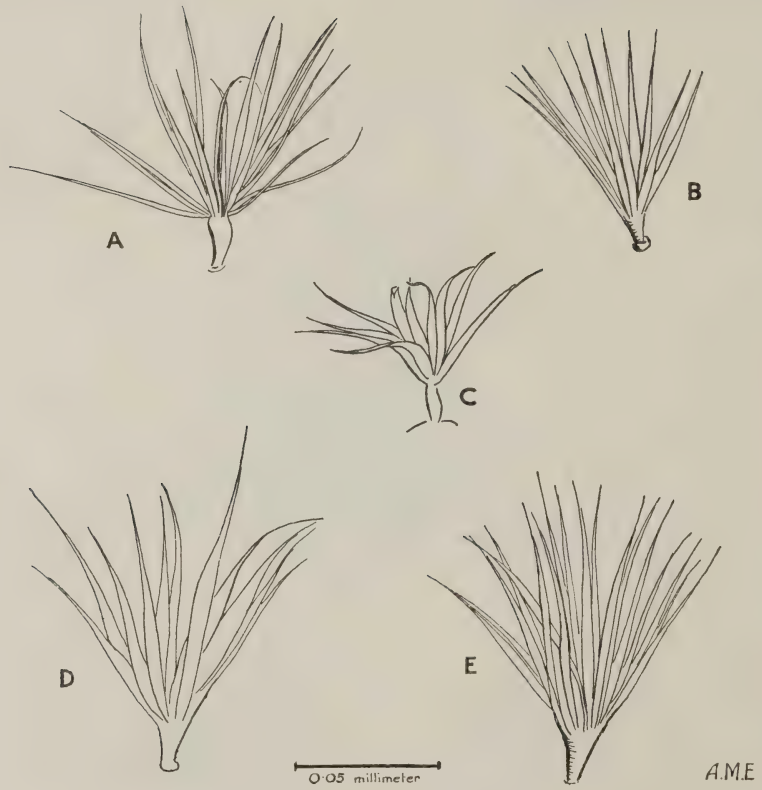


FIG. 3. Palmate hairs of thorax. A.—*A. funestus*; B.—*A. rhodesiensis*; C.—*A. squamosus*; D.—*A. smitbii*; E.—*A. marshalli* var. *freetownensis*.

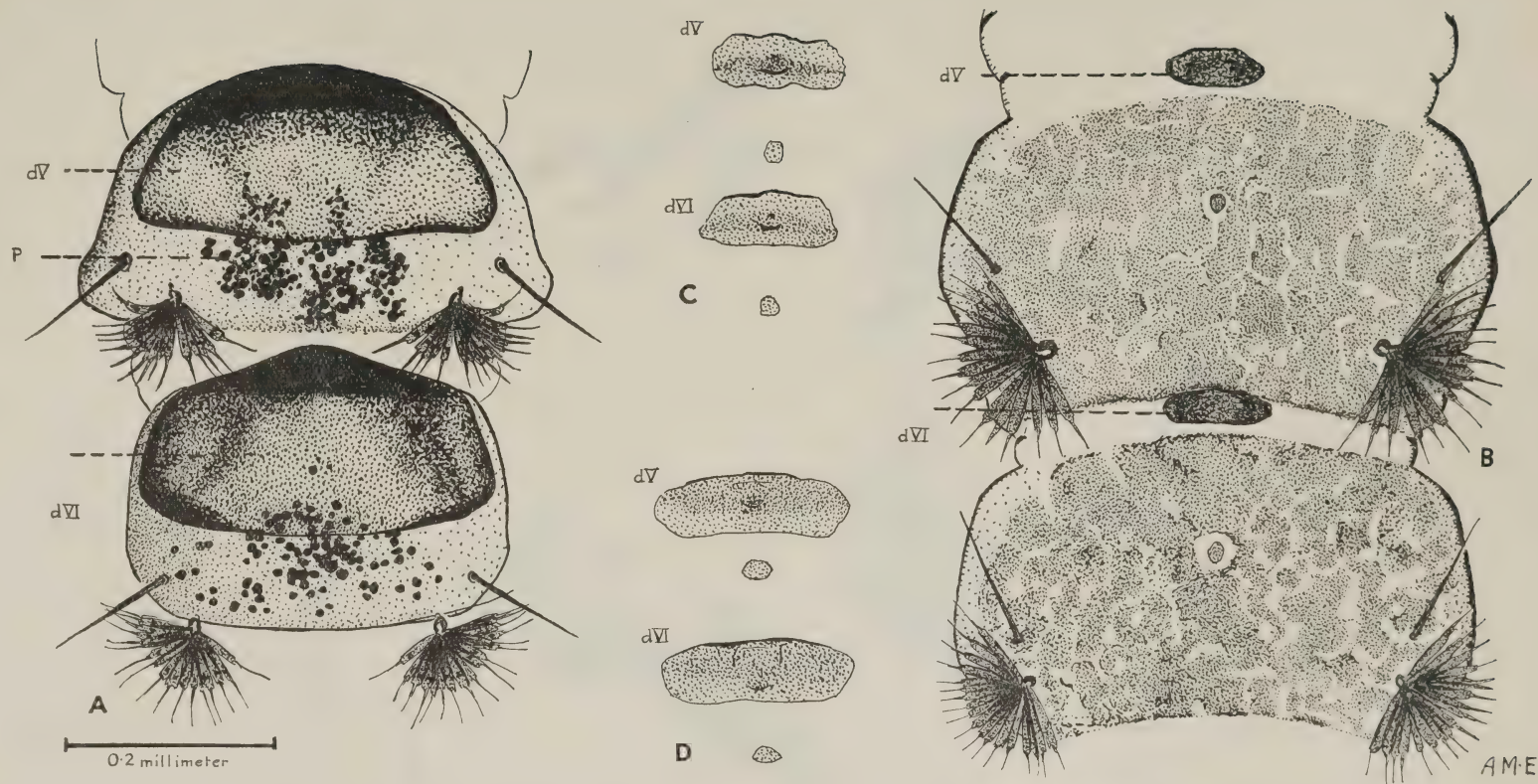


FIG. 4. A.—*A. funestus*, two abdominal segments, dorsal aspect; B.—*A. smitbii*; C.—*A. marshalli* var. *freetownensis*, dorsal plates of two abdominal segments; D.—*A. rhodesiensis*; dV, dVI.—dorsal plates of fifth and sixth segments respectively; p.—pigment.

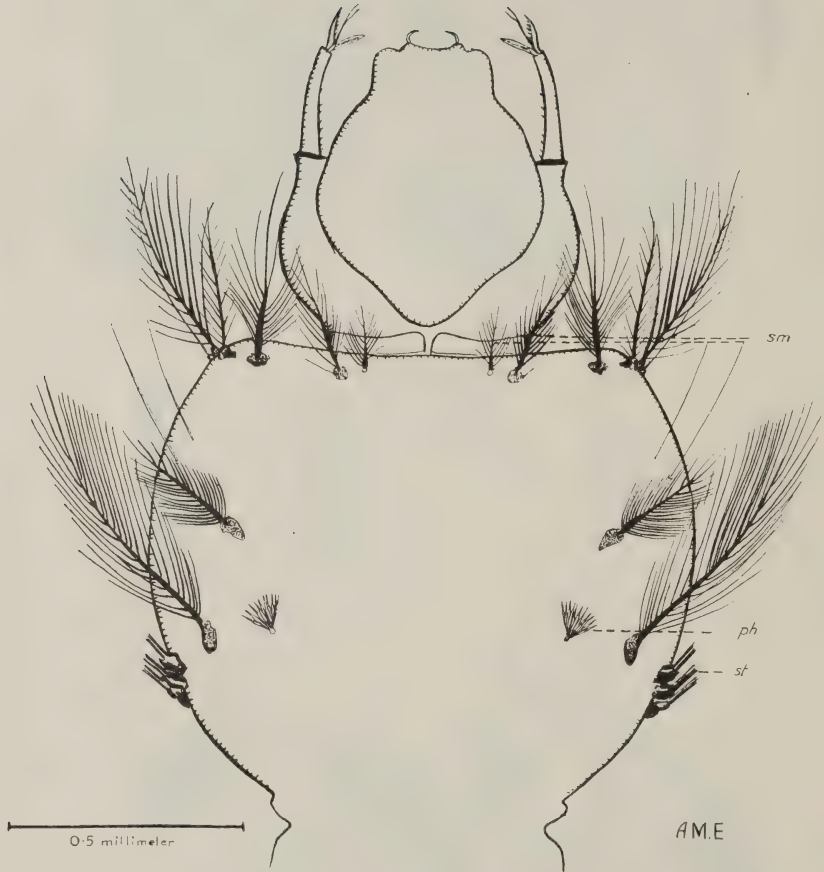


FIG. 5. *A. smithii* (?), diagram showing position of sub-median thoracic hairs; *p.b.*—palmate hair; *s.m.*—sub-median hair; *st.*—stems of plume hairs.

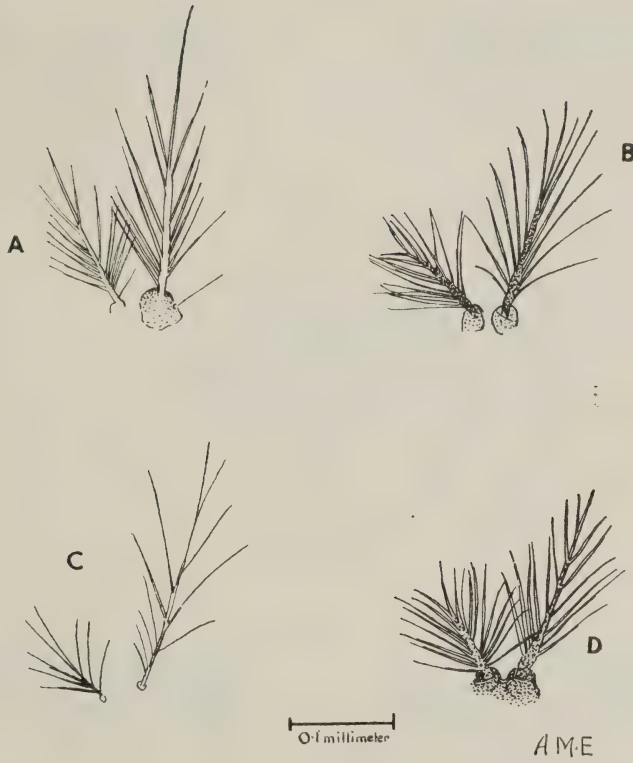


FIG. 6. Sub-median thoracic hairs of A.—*A. smitbii*; B.—*A. rhodesiensis*; C.—*A. costalis*; D.—*A. marshalli* var. *freetownensis*.

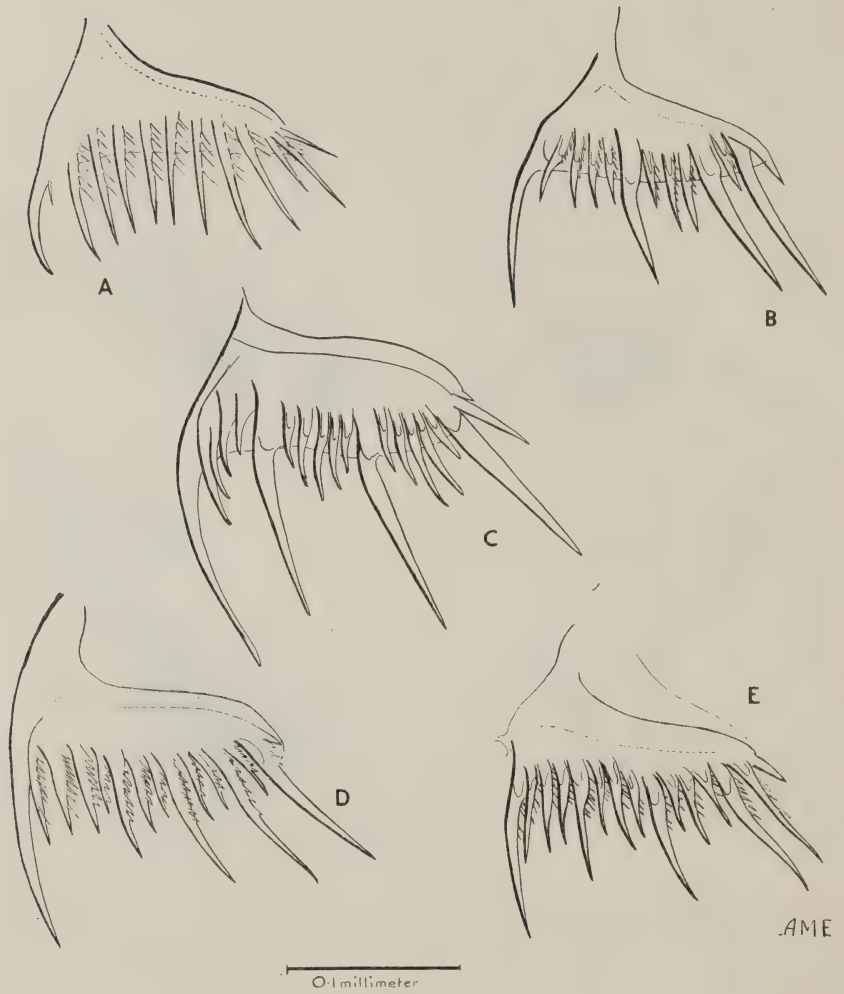


FIG. 7. Lateral combs. A.—*A. smithii*; B.—*A. theileri*; C.—*A. squamosus*; D.—*A. marshalli* var. *freetownensis*; E.—*A. rhodesiensis*.

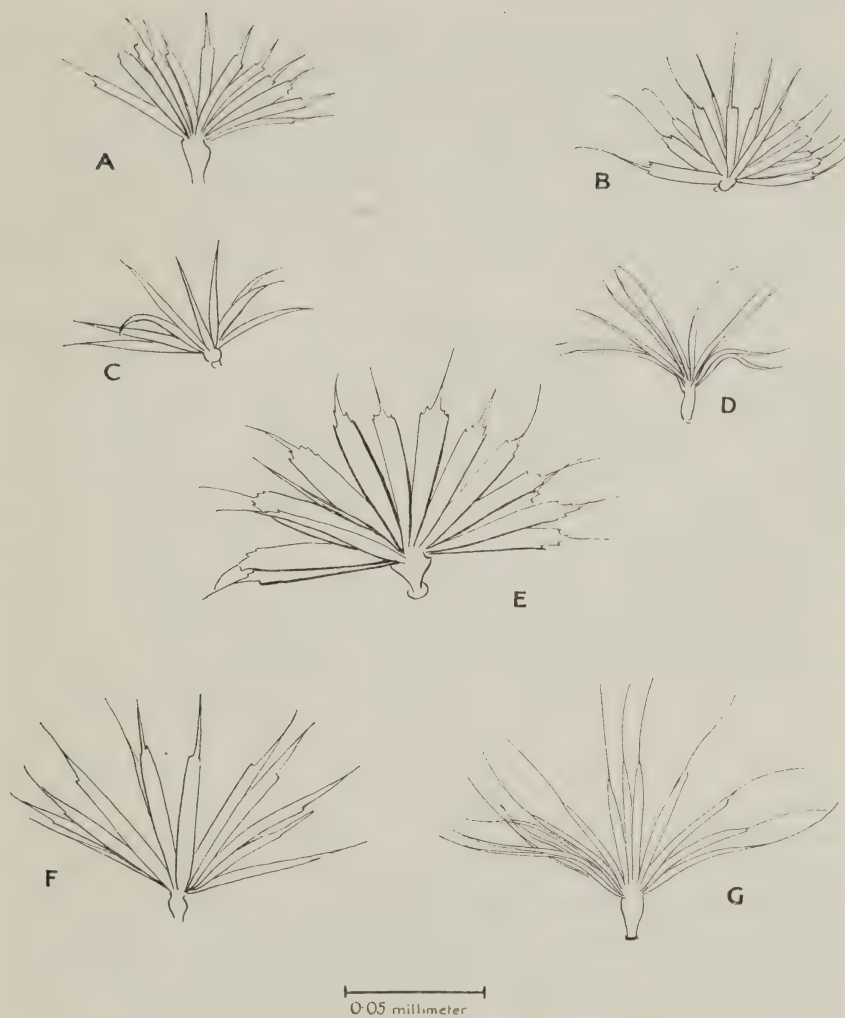


FIG. 8. Palmate hairs of first abdominal segment. A.—*A. ibeileri*; B.—*A. smitbii*; C.—*A. rhodesiensis*; D.—*A. costalis*; E.—*A. marshalli* var. *freetownensis*; F.—*A. squamosus*; G.—*A. funestus*.

DESCRIPTIONS OF THE LARVAE OF THREE SPECIES OF
ANOPHELES AND NOTES ON THE DISTINCTIVE CHARACTERS
OF OTHERS

A. smithii Theo.

Larva. The fourth stage larva is almost invariably dark, appearing black to the naked eye. When examined microscopically the pigment is usually seen to have a bluish green hue. The clypeal hairs are very coarse, the outer are divergent and almost equal in length to the inner. The thorax bears small rudimentary palmate hairs and the lateral combs have the teeth all long and approximately equal in length, except that at the ventral end one or two short teeth occur.

Head. Head capsule unusually heavily chitinised, deep red-brown to black. Antennae with no branched hair on shaft, spines sub-equal, hair divided into two. Inner clypeal hairs (fig. 1, c) long, with delicate branches apically, sometimes extending backwards over the distal third. Outer clypeal hairs as stout as, and only slightly shorter than, inner clypeal, simple, divergent. Pre-antennal more than half as long as inner clypeal, stout, finely plumose; post-antennal branched; occipital simple or bifurcated. Mental plate relatively very narrow. *Thorax.* Plume hairs well developed, sub-median hairs (figs. 5 and 6, A) rather long and slender, the plates at their bases well separated. Palmate hairs (fig. 3, D) with about eleven long slender leaflets. *Abdomen.* Palmate hairs of first abdominal segment (fig. 8, B) small, but leaflets well developed with marked shoulder and filament. Palmate hairs of segments three to seven relatively large, that of fifth segment (fig. 2, G) with longest leaflets about 0.09 mm. and the greatest width about one-ninth of this. Shoulder with one, two or (rarely) three serrations, filament originating rather gradually, length (taken from distal serration to tip) about two-sevenths of the total length of the leaflet and filament. Lateral combs with about eleven sub-equal teeth, markedly serrated. Dorsal plates very small (fig. 4, B). One or two short teeth occur towards the ventral aspect.

A. marshalli var. *freetownensis* Evans.

Larva, Fourth Stage. In life the larva is usually dark grey with blackish pigment; the dorsal plates are small, and palmate hairs

are present on the thorax and first seven abdominal segments ; those of the third to seventh segments are relatively very large.

Head. Antennae with no branched hair on shaft ; terminal hair divided into two or three. Inner clypeal hairs (fig. 1, E) generally simple, occasionally with fine lateral secondary hairs towards the extremity. Outer clypeal hairs simple, slightly less than one-half the length of the inner ; pre-antennal, simple, about equal to the outer anterior clypeal ; post-antennal, branched, occipital simple. *Thorax.* Plume hairs well developed. Sub-median hairs (fig. 6, D) arising from chitinous plates, those of each pair being fused. Palmate hairs (fig. 3, E) large with about eighteen long narrow leaflets. *Abdomen.* Palmate hairs of first segment comparatively large (fig. 8, E) leaflets with well-developed shoulder and filament ; palmate hairs of segments three to seven unusually large, that of the fifth segment (fig. 3, E) with leaflets large (total length *c.* 0.1 mm., width from one-eighth to one-ninth of this), the shoulder much serrated and the filament long and slender, about two-sevenths of the total length of the leaflet. Dorsal plates of normal size (fig. 4, C). Lateral combs (fig. 7, D) with a rather great disparity between the long and short teeth, all the teeth finely serrated.

The larva of this species differs markedly from that of *A. marshalli* Theo., in which the first and second abdominal segments as well as the thorax are devoid of rudimentary palmate hairs (Macfie and Ingram, 1917).

A. costalis Theo.

The larva of this species has been fully described by Hill and Haydon (1907). It can usually be distinguished from the other species by the colour, the pigmented portions being pale brown or, sometimes, green, and the lateral part of the thorax opaque creamy-white. The small size of the abdominal palmate hairs (fig. 2, E) is a constant character.

A. funestus Giles.

As Edwards (1922), and subsequent authors, have pointed out, this species and its allies differ from other Anopheles in the larval stage by the relatively enormous size of the dorsal plates (fig. 4, A).

A. rhodesiensis Theo.

The larva of this species has been described by Christophers and Chand (1916).

Specimens found in the neighbourhood of Freetown are usually very dark, appearing dark grey or blackish to the naked eye, and have paired darker quadrangular areas on the abdominal segments. They may be distinguished from the larvae of *A. costalis* by the presence of small palmate hairs on the thorax (in the living larva these can be seen best by using reflected light), and by the unbranched inner clypeal hairs. The larvae are more difficult to distinguish from those of *A. marshalli* var. *freetownensis*, but the well-separated bases of the sub-median thoracic hairs can readily be seen and the large size of the abdominal palmate hairs in var. *freetownensis* is a striking character.

A. squamosus Theo.

Hill and Haydon (1907) have described the larva of this species in detail. The dendriform, outer clypeal hairs (fig. 1, A) distinguish it at once from the other species which have no branched hair on the shaft of the antenna. *A. pharoensis*, however, shares this character, and Edwards (1912), in his key to the larvae of the African Anophelines, does not distinguish between the two species.

A. theileri Edw.

There seems to be no difficulty in separating the larvae of this species from those of others likely to be met with in Sierra Leone. In addition to possessing the characters given in the key, the larva is unusual in having the smaller teeth of the lateral combs (fig. 7, B) extremely short.

A. obscurus Grünb.

Christophers (1924) has recently separated the African form of *A. umbrosus* Theo. under the name *A. obscurus* Grünb. From the close resemblance between the adults of the two species it seems safe to assume that the larvae of *obscurus* will have the same general characters as those of *umbrosus*.

Anopheles nili Theo.

The accompanying illustrations (figs. 9 and 10) show the characteristic features of a larva found in the Moa River, at Daru, by the senior author in 1924.

The larva was one of several taken from the edge of the river, many of which hatched out, giving rise to two species only, namely, *A. costalis* and *A. nili*. There is, therefore, very little doubt that this larva is that of *A. nili*. A similar but slightly imperfect larva was found in a swamp near Daru. The following is a description of the larva.

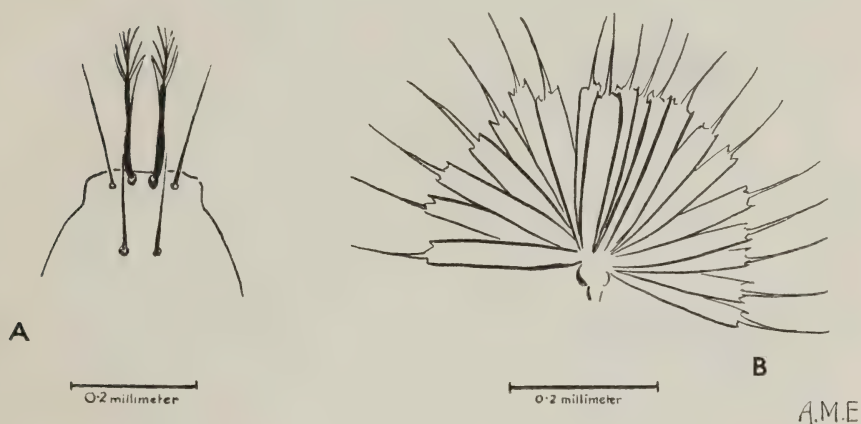


FIG. 9. *Anopheles* sp ? *nili*. A.—clypeal and post-antennal hairs; B.—palmate hair of thorax.

Head. Antennae with no branched hair on shaft. Inner clypeal hairs (fig. 9, A) very thick, widest a short distance beyond the base, distal third with several rather long coarse branches. Outer clypeal hairs slender, simple. Pre-antennal hairs reaching to the edge of the clypeus, simple. *Thorax.* Palmate hairs (fig 9, B) situated at the posterior angles, very large, *c.* 0.14 mm. in diameter, the leaflets with well-developed shoulder and filament. *Abdomen.* Palmate hairs (fig. 10, B) relatively large, the leaflets with filament and rounded, serrated shoulder, markedly incised between serrations. (It should be noted that the palmate hairs in figs. 9 and 10 are drawn to different scales.) Dorsal plates (fig. 10, A) wide, resembling in shape the thicker basal portions of the dorsal plates of *A. funestus*. Lateral combs with long and short teeth.

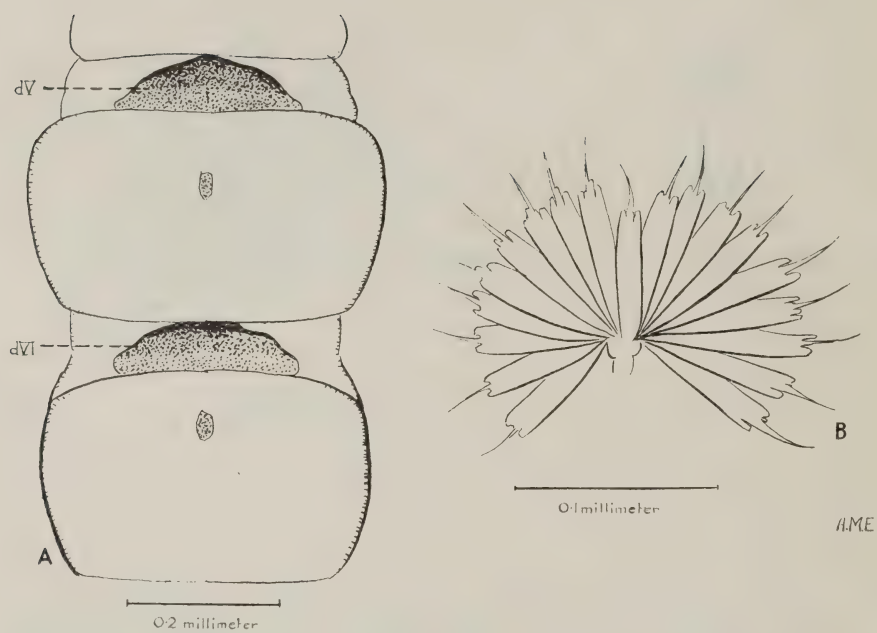


FIG. 10. *Anopheles* sp. ? *nili*. A.—outline of two segments of abdomen; B.—palmate hair of fifth abdominal segment; *dV*, *dVI*.—dorsal plates of fifth and sixth segments respectively.

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EXPLANATION OF PLATE V

Breeding places of Anopheles.

- FIG. 1. Breeding place of *A. rhodesiensis* in the town. The white arrow is pointing to a small pool from which larvae were taken.
- FIG. 2. Breeding place of *A. smithii* above Aureole Bridge. The small rock-pool indicated by the arrow contained larvae of this species.
- FIG. 3. Breeding place of *A. funestus* just outside the town. The lower barb of the arrow is pointing to the floating weeds among which the larvae were found.
- FIG. 4. Breeding place of *A. rhodesiensis* and *A. costalis* in the town.